

REMARKS

Applicants have carefully considered the March 11, 2005 final Office Action, and the amendments above together with the comments that follow are presented in a bona fide effort to address all issues raised in that Action and thereby place this case in condition for allowance. Claims 1-18 were pending in this application. In response to the Office Action dated March 11, 2005, new claims 19-20 have been added. Care has been exercised to avoid the introduction of new matter. Adequate descriptive support for the present Amendment should be apparent throughout the originally filed disclosure as, for example, the depicted embodiments and related discussion thereof in the written description of the specification, including page 17, lines 11-20.

Claims 1-18 were rejected under 35 U.S.C. § 103 for lack of obviousness predicated upon Sameshima et al. (U.S. Pat. App. Pub. 2003/0203624, hereinafter "Sameshima") in view of Lukanc et al (U.S. Pat. No. 6,117,782, hereinafter "Lukanc"). Applicants respectfully traverse.

In the statement of the rejection the Examiner admitted that Sameshima fails to teach the steps of (a) forming a normal taper in the upper part of the concave of the insulating film, which is removed in part in the second polishing step of claims 1-2, 7-8 and 13-14; (b) a sacrificial layer that is formed on the insulating film and selectively removed, as required in claims 3-6, 9-12 and 15-18; and (c) forming the concave in the insulating film by etching the sacrificial film more slowly than the insulating film, as described in claim 4. Nevertheless, the Examiner asserted that one having ordinary skill in the art would have been motivated to modify the methodology of Sameshima by incorporating teachings of Lukanc with respect to the formation of a sacrificial layer and etching technique. Moreover, the Examiner asserted that Lukanc discloses a substrate surface provided with a recess tapered at the mouth of the substrate and

Sameshima discloses a two-step polishing to form damascene wiring. See pages 4-5 of the Office action.

In response to the after-final Amendment submitted on June 13, 2005, the Examiner asserted that Lucanc and the prior art teach that the removal of the tapered corners of the dielectric and/or sacrificial layers is desirable in the final interconnect structure. the Examiner asserted that the taper is caused by conventional etching of the contact hole and/or cleaning process/sputter etching of the contact hole and, therefore, the examiner concluded the that solution of removing the taper is conventional and is addressed by Lucanc and the admitted prior art. Applicants respectfully traverse the rejection.

Initially, Applicants note that although the Examiner includes only Sameshima and Lukanc in the statement of the rejection, the Examiner, in the June 29, 2005 advisory action, cites no less than three additional U.S. patents (You et al., Stamper et al. and Seta et al.) in the explanation of the rejection under 35 U.S.C. § 103. The Examiner's reliance on these additional references, without first citing them in the statement of the rejection, is improper and the rejection is not legally viable for at least this reason. *In re Hoch*, 428 F.2d 1341, 166 U.S.P.Q. 406 (CCPA 1970).

The present invention addresses and solves a particular problem which arises in conventional damascene processing. The particular problem addressed and solved by the claimed invention is that the upper part of an interconnect trench is etched in the form of a taper when a diffusion barrier film is removed by etching. The undesirable formation of such a taper results in a parasitic capacitance and short circuiting failures, particularly as microminiaturization proceeds apace.

Applicants address and solve that problem by strategically controlling the second polishing step during chemical-mechanical polishing (CMP) to remove at least a part of the conventionally formed normal taper in the upper part of a concave formed in the insulating film or of the interconnect trench (independent claims 1 and 2). In this way short circuiting is prevented. Moreover, by providing a sacrificial film on the insulating film according to another embodiment of the present invention, etching of the corner in the upper part of the concave formed in the insulating film or in the interconnect trench is prevented, and removal of a taper in the upper part of a concave or the interconnect trench is facilitated (independent claims 3 and 5). None of the applied references appreciates the problem addressed and solved by the claimed invention which is illustrated in Fig. 2A of the present application, i.e., the formation of a taper, or normal taper, during conventional methodology employed when etching the upper part of the interconnect trench 117 during etching of the diffusion barrier 105. Absent any such appreciation of the problem, it cannot be said that one having ordinary skill in the art would have been realistically motivated to modify any steps of the applied references to eliminate that problem.

Applicants again submit that Lukanc requires a taper as an essential structure in order to prevent formation of overhanging deposits at the corners of the opening. As described at col. 11, lines 52-57, Lukanc discloses a structure, depicted in FIG. 4, that includes a mouth surface portion having a tapered width decreasing in size with depth below the substrate surface 4 and advantageously exhibits a substantially reduced tendency for overhang formation by the nucleation seed layer 8, relative to that illustrated in FIG. 3A. Moreover, as described at col. 12, lines 16-23, the tapered mouth surface portion, which provides a continuously increasing width at the upper portion of the recess, is able to accommodate the additional plating thickness due to

increased deposition rates thereat, thereby resulting in a substantially continuously vertically oriented sidewall with a relatively sharp transition into a horizontally oriented substrate surface.

In direct contrast, the present claimed subject matter is directed to resolving the problem with parasitic capacitance and short circuit failure generated as a result of forming of a taper. Applicants submit that contrary to the Examiner's assertion, one of ordinary skill would not have been realistically motivated to combine the teachings of the references to arrive at the claimed inventions. The present claimed subject matter addresses and solves a particular problem which arises in conventional damascene processing. The particular problem addressed and solved by the claimed subject matter is that the upper part of an interconnect trench is etched in the form of a taper when a diffusion barrier film is removed by etching. The undesirable formation of such a taper results in a parasitic capacitance and short circuiting failures, particularly as microminiaturization proceeds apace. It is well settled that the problem addressed and solved by a claimed invention must be given consideration in resolving the ultimate legal conclusion of obviousness under 35 U.S.C. § 103. *North American Vaccine, Inc. v. American Cyanamid Co.*, 7 F.3d 1571, 28 USPQ2d 1333 (Fed. Cir. 1993); *Northern Telecom, Inc. v. Datapoint Corp.*, 908 F.2d 931, 15 USPQ2d 1321 (Fed. Cir. 1990); *In re Newell*, 891 F.2d 899, 13 USPQ2d 1248 (Fed. Cir. 1989); *In re Nomiya*, 509 F.2d 566, 184 USPQ 607 (CCPA 1975).

Applicants address and solve that problem by strategically controlling the second polishing step during chemical-mechanical polishing (CMP) to remove at least a part of the conventionally formed normal taper in the upper part of a concave formed in the insulating film or of the interconnect trench (independent claims 1 and 2). In this way short circuiting is prevented. Moreover, by providing a sacrificial film on the insulating film according to another embodiment of the present invention, etching of the corner in the upper part of the concave

formed in the insulating film or in the interconnect trench is prevented, and removal of a taper in the upper part of a concave or the interconnect trench is facilitated (independent claims 3 and 5).

Absent any such appreciation of the problem, it cannot be said that one having ordinary skill in the art would have been realistically motivated to modify any steps of the applied references to eliminate that problem. In this respect see *Ecolochem Inc. v. Southern California Edison, Co.*, 227 F.3d 1361, 56 USPQ2d 1065 (Fed. Cir. 2000). Moreover, the failure of the applied references to express any appreciation of this problem addressed and solved by the claimed invention constitutes evidence of nonobviousness. *North American Vaccine, Inc. v. American Cyanamid Co.*, *supra*; *Northern Telecom, Inc. v. Datapoint Corp.*, *supra*; *In re Newell*, *supra*; *In re Nomiya*, *supra*.

Based upon the foregoing it should be apparent that a *prima facie* basis to deny patentability to the claimed invention has not been established for lack of the requisite factual basis and want of the requisite realistic motivation. Moreover, upon giving due considerations to the problem addressed and solved by the claimed invention, the conclusion appears inescapable that one having ordinary skill in the art would not have found a claimed invention as a whole obvious within the meaning of 35 U.S.C. § 103. *Jones v. Hardy*, 727 F.2d 1524, 220 USPQ 1021 (Fed. Cir. 1984).

Applicants, therefore, submit that the imposed rejection of claims 1 through 18 under 35 U.S.C. § 103 for obviousness predicated upon Sameshima in view of Lukanc is not factually or legally viable and, hence, solicit withdrawal thereof. moreover, new claims 19-20, which further describe independent claim 1, are free from the applied art in view of their dependency from claim 1.

Application No.: 10/724,111

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

McDERMOTT WILL & EMERY LLP



Brian K. Seidleck

Registration No. 51,321

600 13th Street, N.W.
Washington, DC 20005-3096
Phone: 202.756.8000 BKS:idw
Facsimile: 202.756.8087
Date: August 11, 2005

**Please recognize our Customer No. 20277
as our correspondence address.**